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Spatiotemporal variations of isotopes in snow and snowmelt in the subarctic setting at Pallas catchment, Finland

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Due to the rise in global temperature, changes in precipitation patterns are predicted particularly in Arctic regions. Such changes in patterns and modifications in typical snow to precipitation ratios will affect the snowpack thickness and the timing of snow accumulation and snow melting. Stable water isotopes (δ^2H, δ^{18}O) are one of the latest tools in exploring and tracing such changes, however, snow isotope and particularly snowmelt isotope datasets are rarely available which hamper the high-resolution isotope based hydrological investigations in Arctic regions. In this study, we perform an investigation for evaluating spatiotemporal variations in stable isotopes of snow and snowmelt water. Our Pallas research catchment is located in a subarctic setting in northern Finland. The measurements were made at 11 locations along a 2 km snow survey, which is established on the transect of the catchment, comprising of different landscape features (i) forested hillslope, (ii) mixed forest and (iii) open mires. We sampled depth-integrated bulk snowpack and fixed 5 cm incremental snow stratigraphy profile in snowpits. For snowmelt sampling, we used a system of snowmelt lysimeter, deployed at 11 locations. The bulk snowpack samples were collected biweekly, fixed 5 cm incremental stratigraphic snowpit samples during the period of maximum snowcover thickness and during the start of peak melting, during the peak melting and after the peak melting. Snowmelt samples were collected daily during the spring season until the complete disappearance of snow with complementary measurements of snowmelt flux, snow density and snow water equivalent. Our results indicate the higher mean values of snowmelt isotopes relative to the bulk snowpack and surface snow isotopes. The snow isotope profiles in snowpack reveal that the isotopes at the snow-air and snow-ground interfaces are enriched in heavier isotopes as compared to the middle of the snowpack. The snowmelt isotopes show that the isotopes are initially depleted in heavier isotopes but with the progress of melting, they start to become enriched. A well defined depleted to enriched pattern is observed at different locations in the forested hillslope area, while a relatively dispersed depleted to enriched pattern is observed at different locations in the mixed forested area. Our unique high-resolution dataset of snow and snowmelt isotopes will be useful in many applications; such as for evaluating post-depositional isotope modification in the seasonal snowpack, developing tracer-aided mass and energy based snow models. The establishment of snowmelt isotope dataset, showing spatiotemporal variability of snowmelt isotopes, is an important step forward in isotope based plant-water uptake studies and hydrological analyses in snow-influenced catchments.